THE EFFECTS OF DIETHYLSTILBESTROL ON PELVIC AREA, PERCENT CALF CROP, CALVING DIFFICULTY AND BODY SIZE RELATIONSHIPS IN HEREFORD HEIFERS

by

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INTRODUCTION

It has long been known through research that the administration of diethylstilbestrol (DES) to finishing beef cattle will improve gains and feed efficiency. Research data has also indicated that varied levels of DES will cause stimulation of the mammary tissues, induce false heat and bring about relaxation of the broad ligaments, distort the rump and tail head and interfere with normal ovarian function.

The potential and benefits derived from the use of DES with market cattle are tremendous. However, research on the use of DES for breeding cattle has not been as plentiful as that with market cattle. The purpose of this study was to determine the effects of DES on the following:

1. Dams pelvic area and hook width
2. Percent calf crop
3. Calf birth weight
4. Ease of calving
5. Dams body weight

LITERATURE REVIEW

Diethylstilbestrol, Mode of Action, Absorption

DES is a synthetic estrogen like compound developed in England in 1938, Marshall et al. (1948). Since that time it has been used on many species of livestock, and its use has been shown to have varied effects upon reproduction, muscle and skeletal growth, lactation, and probably several other aspects which have as yet been undetermined. The exact mechanisms by which DES works have not been found; we know what DES does but not how. The work of Hale et al. (1959) indicated that the absorption rate of DES pellets implanted subcutaneously in the ear was a function of surface area of the pellet and not related to the total number of pellets implanted. The absorbance rate of a 36 mg. implant (three 12 mg. pellets) was .22 mg. per day or 24.5 mg. was absorbed in 112 days. Even though the pellet was completely absorbed, the response of the implant was measurable several days after absorption. When administered subcutaneously as an implant, DES will appear first in the peripheral blood. However, when administered orally, DES first appears in the hepatic circulation system. What affect these separate routes of entry of DES into the metabolic system would have in terms of the amount of DES to produce the desired growth response is not known, Hale et al. (1959). While a route of entry between oral and implanted DES into the metabolic pathways may be a factor in determining the amount of DES required to produce a certain effect, this doesn't necessarily mean there is a difference in the final target organs, Hale et al. (1959). Apparently, however, the efficiency of utilization of implanted DES is much greater than that of orally administered DES. Perry et al. (1958) found that when steers were implanted with 36 mg. of DES or fed 10 mg. DES per day the results were the same between both treatment levels.

More research needs to be done on a cellular level to determine the mechanisms involved with hormone function. Once we know how a hormone functions, then we will be more able to achieve the desired treatment responses.

Effect on Daily Gain, Feed Efficiency, and Consumption

According to Goetsch (1955) DES will increase rate of gain and feed efficiency of beef cattle whether administered as an implant or fed orally. Response also seemed greatest when animals were on a fattening ration rather than a growing or roughage ration.

When dairy heifers were fed 10 mg. of DES per day from 6 months of age until within 10 days of calving, feed consumption increased. However, the control group of heifers were more efficient, Wickersham and Schultz (1964). Dinusson et al. (1948) reported that beef heifers when treated with 42 mg. of DES administered subcutaneously consumed significantly more feed, were more efficient, and gained faster than their control. Feeding 10 mg. DES per day to cattle fed on a fattening ration for 193 days resulted in the DES steers gaining faster and more efficiently, Wallentine et al. (1961). Richardson et al. (1955) found that feeding 10 mg. of DES orally to beef cattle on a roughage type ration resulted in a slight increase in gain but no increase in feed efficiency for treated cattle.

Dairy heifers fed 5, 10, 15 mg. of DES per day from 4 months of age to 15 months made more rapid gains and were more efficient than their control group, Bush and Reuber (1963). Williams and Baker, Jr. (1961) reported that beef heifers implanted with 24 mg. of DES and wintered on oat and rye pasture had increased gains over the non implanted group. Beef steers and heifers implanted with 60 mg. of DES and finished to slaughter weight out gained the control group, Clegg et al. (1951).

Perry et al. (1955) reported that steers on a finishing ration fed 10 mg. of DES per day made their most rapid gains and were the most efficient the first 28 days on treatment. Hereford steers on pasture implanted with 24 mg. of DES made significantly greater gains over the control group (.69 lb.) and were more efficient. Steers and heifers implanted with 60-120 mg. of DES and grazed on irrigated pasture failed to gain more than the control group. When the pasture ration was supplemented with 5 lb. of barley, the treated cattle out gained the control group by .23 lb. per day, Clegg and Cole (1954).

Beef heifers implanted with 40 mg. of DES prior to a 196 day feeding period made no significant increase in daily gain; but when fed 5 mg. DES daily plus the original implant or when implanted every 28 days with 20 mg. of DES, significant increases in daily gains were found, Neumann et al. (1956). Fletcher et al. (1957) reports that yearling beef heifers (12-14 months old) implanted with 24 mg. of DES and fed a high roughage ration for 63 days made significantly increased daily gains. Steers and heifers fed on a fattening ration and implanted with 36-72 mg. DES had increased gains over the control group, Klosterman et al. (1958).

What action on the animal's metabolism system by DES causes increased body growth and weight gain? Struempler and Burroughs (1959) found that immature ruminants fed 5 mg. of DES per day and 10 mg. DES per day had an increase in nitrogen retention; also, the total amount of STH increased in the anterior pituitary and increased STH was present per unit of body weight.

Physical and chemical analysis of the 12th rib indicated that DES caused an increase in percent protein, decrease in percent fat, and increased nitrogen retention. Young heifers also had an increase in percent water and bone, Clegg and Carroll (1956). Heifers that were grazed on irrigated pasture and slaughtered had an increase of STH and a reduction in external and internal fat, Clegg and Cole (1954). Clegg and Cole (1954) found DES stimulated an increase in secretory activity of the anterior pituitary, which in turn, stimulated the release of a protein anabolic hormone from the adrenal gland possessing androgenic activity, which they felt was a causitive factor for weight gain.

Even though we don't know the exact mechanisms involved, it has been firmly established that DES will increase daily gain, increase feed efficiency and increase feed consumption.

Effect of DES on Skeletal and Muscle Changes

Hereford heifers of an average weight of 500 lb. were implanted in the shoulder with 42 mg. DES and put on full feed for 185 days. Results of this treatment indicated an increase in length of leg, length of back, and width of back over their control. Within a week following implantation, the tail heads showed elevation, Dinusson et al. (1950). Beef heifers implanted with 20 mg. of DES every 28 days and fed for 196 days showed high tail heads and low loins, Neumann et al. (1956). Andrews et al. (1954) indicated that beef steers injected with 60-120 mg. of DES showed elevated tail heads and relaxation of the broad ligaments between the sacrum and ischium. Beef heifers fed 12 mg. per day of DES on either a high grain, high roughage or 50% roughage ration resulted in no rise in tail head or any other undesirable condition, Burroughs et al. (1955).

Open heifers and dry cows of dairy breeding were injected with 10 mg. of stilbestrol (in a 1 ml. cotton seed oil carrier) in the neck daily for 4-6 injections. Then 2 ml. (20 mg. stilbestrol) were injected for three injections per week until lactation began. Upon lactation, the injections were discontinued with six heifers and continued with eight heifers for 32-89 days after onset of lactation. The result of this treatment was a rise in tail heads in the first 3 weeks, and they continued to rise progressively as long as the treatment continued. Under high prolonged levels, one heifer suffered a double partial dislocation of the ilio-sacral ligaments and a broken tail head, Marshall et al. (1948). Perry et al. (1955) showed that steers fed 10 mg. of DES daily developed higher tail heads and also the relaxation of the lumbar vertabrae which caused a lowering of the loin.

Edgreen and Calhoun (1956) found that estrogenic substances administered to mice caused an increase in the density of the femora by causing proliferation of the medullary bone. Also, daily doses of DES increased density with increased time of treatment. Wickersham and Schultz (1964) reported that dairy heifers fed 10 mg. of DES daily from 6 months of age until within 10 days of parturition had no significant effect on skeletal growth.

Walker (1961) reported that Hereford steers implanted with 24 mg. of DES and implanted with 24 mg. of DES and then reimplanted with 24 mg. of DES later in the trial resulted in a change in the pelvic bone structure when compared to the control group. The treated groups, composed of two levels of DES, both displayed an increase in pelvic girdle size, weight, and the pelvic opening was larger than the control groups. The reimplanted group's pelvic measurements were slightly larger than the single implant group.

Effect of DES on Mammary Development and Lactation

Neumann et al. (1956) found that beef heifers exhibited excessive mammary growth when implanted every 28 days for a 196 day feeding period with 20 mg. of DES. Dairy heifers receiving 10 mg. of DES daily from age 4-14 months developed no excessive mammary development, Krawczyz and Olson (1961). Hereford heifers of an average weight of 500 lb. implanted with 42 mg. of DES in the shoulder and put on full feed for 185 days displayed an increase in mammary gland development and an increase in teat length. These conditions regressed slightly towards the end of the feed period, Dinusson et al. (1950). Clegg et al. (1951) reported that beef heifers implanted with 60 mg. of stilbestrol had significant increases in mammary development and considerable milk was evident at time of slaughter.

Beef steers implanted with 60-120 mg. of DES exhibited an increase in teat length from .5 to 1.0 inches over the control groups, Andrews et al. (1954). Clegg and Cole (1954) showed that steers and heifers implanted with 60-120 mg. of DES and grazed on irrigated pasture had increased mammary growth, and the heifers had milk in their udders.

Open heifers and dry cows of dairy breeding were injected with 10 mg. of DES in the neck daily for 4-6 injections and then injected with 20 mg. 3 times a week until brought into lactation by the estrogenic activity. Most heifers showed rapid udder development and began to milk by 14-17 days after initiation of treatment, Marshall (1948).

Oral administration of 10 mg. of DES daily resulted in an increase in teat length in steers on a fattening ration, Perry et al. (1955).

Estrogenic Effect on Vulva, Incidence of Prolapse and Riding

Clegg et al. (1951) showed that implanting beef heifers being fed a finishing ration with 60 mg. of DES caused some of the heifers to have vaginal prolapses. Hyperemia and swelling of the vulva were exhibited the first 10-14 days by beef heifers following implantation with 42 mg. of DES, Dinusson et al. (1950). Burroughs et al. (1955) found no evidence of excessive riding or evidence of prolapse in beef heifers fed 11 mg. of DES daily. Beef heifers implanted with 36-72 mg. showed no evidence of prolapse, Klosterman et al. (1958). Beef heifers implanted every 28 days with 20 mg. of DES for a feed period of 196 days displayed prolapsed uteruses, Neumann et al. (1956). Clegg and Cole (1954) reported that some heifers implanted with 60-120 mg. of DES displayed vaginal prolapses at 8-10 weeks after treatment.

Open heifers and dry cows of dairy breeding injected with 10 mg. of DES in the neck daily for 4-6 days and then injected with 20 mg. three times a week until lactation began, displayed sexual excitation, mounting, and standing to be mounted for periods of 2-4 days at a time, Marshall et al. (1948). Ten mg. of DES fed daily to dairy heifers from 6 months of age to within 10 days of calving resulted in increased vascularity and turgidity of the vulva 7-10 days following initiation of the treatment, Wickersham and Schultz (1964).

Clegg and Carroll (1956) found that young heifers implanted with DES displayed no incidence of vaginal prolapse but that there was an appearance of looseness and edema around the area of the vulva. Yearling heifers fed a high roughage ration and implanted with 24 mg. of DES exhibited excessive mucous secretions but no vaginal prolapses were evident, Fletcher et al. (1957).

Effect of Estrogen on Gonadotrophic Hormones

Wiltbank et al. (1961) injected 18 month old beef heifers with normal ovarian function with estradiol valerate or estrone in 10, 20, 25, 50, 100 mg. doses. Results of this work showed that regression of the corpus luteum (CL) was induced due to lack of sufficient luteinizing hormone (LH) levels. No early regression of the CL was noted when the estrogen injections were followed by injections of follicle stimulating hormone (FSH) and LH. Heifers injected with 10, 20, 25, or 50 mg. of estrone showed evidence of luteal activity, but heifers treated with 100 mg. of estrone or estradiol valerate had little or no ovarian activity.

The exact mode of action of estrogens causing early regression of the CL is not known. The action could be directly on the CL itself or through intermediary organs, Wiltbank et al. (1961). Research showed that estrogen acted on the pituitary to inhibit the supply of gonadotrophin, Meyer and Hertz (1937). Loy et al. (1960) postulated that the action of estrogens released the LH stored in the pituitary, causing an inadequate supply of LH after the initial release.

Meyer (1946) postulated that blood levels of estrogen govern the secretion of FSH and LH from the pituitary. Work with parabiotid rats indicated that moderate blood levels of estrogen decreased FSH levels but increased LH secretion.

High levels of exogenous estrogens given to intact animals caused ovarian atrophy by suppression of gonadotrophin secretions. Lower levels induced the release of LH and subsequent ovulation in several species including the cow, sheep, rat, and rabbit, Anderson et al. (1964). The factors directly responsible for at least the latter stages of follicular development are present in the pituitary gland. Initially, estrogen acts on the pituitary gland resulting in the release of LH. If estrogen levels continue, the result is a reduction in LH secretion. It has also been shown that large dosages or levels of estrogen will decrease the secretion of FSH, Dutt (1953). Estrogens will not stimulate the release of LH in animals which do not ovulate spontaneously, Dutt (1953).

Finerty and Meyer (1950) using ovariectomized rats injected subcutaneously with .025 mg., .10 mg., .50 mg., and 5.0 mg. of dienestrol for 10 days found the high pituitary gonadotrophic content of casteration wasn't changed significantly by low dienestrol injections (.10 mg. or less). They found, however, that the pituitary gonadotrophic content was markedly reduced by levels of 5.0 mg. Dienestrol exerted effects upon the function of the hypothalamus similar to the effects caused by estradiol and DES.

Greep and Jones (1950) stated that an elevation of the estrogen level in intact animals may under some circumstances effect a release of the LH in the pituitary. However, they felt the major effect was the reduction in the synthesis of LH.

Immature female rats were injected daily for 10 days with three levels of alpha estradiol; .002 mg. - .009 mg., .012 mg. - .02 mg., and .03 mg. - .05 mg. Results indicated that there was a decline in ovary weight at the .002 mg. - .009 mg. level; an increase in ovarian weight was observed at the .012 mg. - .02 mg. level. A second decrease of ovarian weight resulted when the alpha estradiol level was from .03 mg. - .05 mg. It was then concluded that the gonadotrophic hormone secretion was decreased by alpha estradiol levels within the physiological limits, Barnes and Meyer (1951). The ovarian decrease in weight at the .002 mg. - .009 mg. levels was caused by secretion of smaller amounts of FSH. When estrogen was injected in levels of .012 mg. - .02 mg., there was an increased secretion of LH by the pituitary. The LH caused a greater production of indogenous estrogen by the ovaries which in turn produced further uterine hypertrophy. LH also caused luteinization of the follicles and an increase in ovarian weight. Under long term administration, the LH activity of the pituitary is decreased due to exhaustion of the pituitary supply, Barnes and Meyer (1951). Loy et al. (1960) postulated that estrogen caused the release of LH.

Research indicates that exogenous estrogen will cause the initial release of LH from the pituitary, and this release soon depletes the pituitary reserve. Further research on the mechanisms involving the release of gonadotrophic hormones is needed.

Influence of Estrogen on Ovarian Structure and Function

Wickersham and Schultz (1964) reported that dairy heifers fed 10 mg. of DES per day from 6 months of age to within 10 days of calving had no effect on incidence of cystic ovarian structures (greater than 20 mm.), dimensions of the ovaries, frequency of ovulation failure, or frequency of double ovulation.

Open dairy heifers and dry cows were injected with 10 mg. of DES in the neck daily for 4-6 days, and then injected three times a week with 20 mg. until lactation resulted. Rectal examination of the tracts revealed non function of ovaries during periods of excitation followed by a period of quiescence after which ovulation occurred, Marshall et al. (1948).

Hereford heifers implanted in the shoulder with 42 mg. of DES and full fed for 185 days had fairly normal ovaries, CL's were present indicating ovulation, graafian follicles and large numbers of small 2-5 mm. follicles were present, Dinusson et al. (1950). Williams and Baker (1961) found that beef heifers implanted with 24 mg. of DES and wintered on oat and rye pastures produced no significant ovarian abnormalities. Both treatment and control groups exhibited cystic follicles. Richardson et al. (1955) reported that beef heifers fed 10 mg. of DES per day had smaller ovaries and fewer developing follicles than their controls at slaughter. Cycling, pregnant and hysterectomized heifers were treated with 50 mg. of exogenous estrogen in a single intra-muscular injection using estrone, estradiol 17a, estradiol 17b, and a 5 mg. injection of estradiol valerate. Injections were made on day 5 on cycling heifers and the 35th day of conception of the pregnant heifers. All heifers were bilaterally ovariectomized 7 days after treatment. Results indicated no significant differences in CL weight between treatment groups. Treatment groups exhibited reduced CL in comparison to their controls. Also, estrogen treatment reduced ovarian follicular fluid weight and caused a general depression in the number of follicles less than 15 mm. in diameter, Kaltenbach et al. (1964).

Sawyer (1959) demonstrated that estrogen caused spontaneous ovulation in the rabbit. During winter and spring a considerable number of mature estrogen treated female rabbits ovulated in the absence of coital stimulation indicating that exogenous estrogen was in some manner affecting the release of pituitary ovulating hormone (LH).

One hundred mg. of DES injected into dairy heifers on the 16th day of estrous caused ovulation failure and formation of large luteinized cysts. Injection with lower levels caused little or no alteration of the cycle, Kidder (1954). Wiltbank et al. (1961) reported that beef heifers injected with 10, 20, 25, and 50 mg. of estrone displayed evidence of luteal activity. Heifers injected with 100 mg. of estrone had inactive ovaries, little or no follicular growth, or had large follicles (20 mm. or more).

Anderson (1964) suggested that high levels of exogenous estrogen given to intact animals caused ovarian atrophy by suppression of gonadotrophin secretion while low levels of estrogen induced the release of LH and subsequent ovulation.

Small daily injections of estradiol (20-640 mcg.) starting on day 6 of estrous tended to reduce CL weight, progesterone content, and concentration by the twelfth day of estrous, Niswender et al. (1965). Estrogen if administered in large doses over a period of time will result in inactivity of the ovary and atrophy, Dutt (1953). Sixty to 120 mg. of DES produced several large cystic follicles in beef heifers and the ovaries contained fewer CL, Clegg and Cole (1954).

Influence of Exogenous Estrogen on Estrous and Conception

Wickersham and Schultz (1964) fed 10 mg. of DES daily to dairy heifers from 6 months of age to within 10 days of parturition. The results showed that the DES had no effect on attainment of sexual maturity and that the regularity of estrous wasn't significantly affected as far as intensity or duration. The control group's percent conception at first service was 83.3% versus 57.1% for the treated heifers.

Beef heifers on a fattening ration, average weight 500 lb., were implanted with 42 mg. DES in the shoulder and fed for 185 days. Results of this study indicated that estrus was irregular due to the DES implant, Dinusson et al. (1950). In post partum beef cows treated with progesterone and estrogen there was a greater response to exogenous estrogen in the interval to first estrus than in the interval to first ovulation. This suggested that behavioral estrus wasn't always accompanied by a response of endogenous endocrine activity and ovulation. This indicated that estrogen administered following progesterone treatment may cause behavioral estrus without subsequent ovulation, Foote and Hunter (1964).

Asdell et al. (1945) showed that 600 rat units of estradiol benzoate will induce estrus in ovariectomized heifers. Dairy heifers fed 10 mg. of DES daily required 1.5 services per conception versus 1.4 services for the control group; estrous cycles were normal, Krawczyz and Olson (1961). Ulberg and Lindley (1960) found that estrogen given subsequent to progesterone treatment initiated estrus which was followed by ovulation. They concluded that estrogen treatment didn't alter the estrus-ovulation interval following progesterone treatment, but decreased variation in the time of estrus following progesterone treatment.

Continuous feeding of DES to dairy heifers at levels of 5, 10, and 15 mg. of DES daily from 4 months to 15 months of age had no effect on ability to conceive and produce a normal calf. There was some indication that reproduction or conception was impaired in a few cows fed 15 mg. of DES starting 30 days post-partum, Bush and Reuber (1963). Fletcher et al. (1957) reported that yearling beef heifers implanted with 24 mg. of DES and fed a high roughage ration exhibited excessive mucous secretions and prolonged estrus.

Ease of Calving in Relation to Pelvic Girdle Area and Body Size Relationships of the Dam

Bellows et al. (Undated) reported that in a study of early calf losses over a 7 year period representing 4,500 parturitions, 308 calves were lost between birth and weaning. Forty-nine percent or 152 of the dead calves exhibited no detectable skeletal or visceral abnormalities at autopsy. Autopsy results indicated over 60% of the calves displayed bruises and hemorrhages or injuries of varying degrees indicating a slow or difficult parturition.

Wiltbank (1961) reported the proportion of first calf heifers having dystocia ranged from 15-27% in a 3 year study involving 380 first calf heifers. He believed that calving difficulty could be predicted by measuring the pelvic opening via the rectum using a sliding metal caliper. The size of the pelvic girdle opening is important for normal parturition. The pelvic opening area may be determined by taking two measurements, the height of the opening measured from the symphysis pubis to the backbone and the width of the opening measured between the shafts of the ilium. These two measurements in cm. multiplied together give the open area in square centimeters. The pelvic opening areas range from 190-360 sq. cm. Four hundred and fifty calves were measured by Wiltbank (1961) at parturition to determine if size of calf had any effect on calving dystocia; size of heart girth, head width, head length, shoulder width, hook width, and also body weight were recorded. It was found that the pelvic girdle opening was a better indicator of predicting calving difficulty than calf size. Wiltbank predicted calving difficulty if the pelvic area ranged from 190-229 sq. cm. and no difficulty if pelvic area ranged from 230-290 sq. cm.

Lefever (Undated. Unpublished mimeograph material, U. of Wyom., Laramie.) measured the pelvic girdle opening by the same technique used by Wiltbank (1961). Indications were that yearling beef heifers prior to breeding should have a pelvic area opening of 140+ sq. cm. to have a normal parturition of a 70 lb. calf at two years of age. The pelvic area opening should be 190 sq. cm. 3 months prior to parturition for a 2 year old or 230 sq. cm. 3 months prior to parturition as a 3 year old, Lefever (Undated. Unpublished mimeograph material, U. of Wyom., Laramie.).

Studies involving 178 first calf 3 year old beef heifers whose pelvic areas were determined 3 weeks prior to the beginning of a 50 day calving season showed the following data, Bellows et al. (Undated).

	Mean	Standard Deviation
Pelvic area, sq. cm.	294.7	23.4
Hip width, cm.	50.7	2.4
Rump length, cm.	49.8	2.1
Body weight, kg.	479.0	14.2

The correlations among the internal measurements (pelvic area) and the three external measurements were calculated and standard partial regression coefficients determined as shown below, Bellows et al. (Undated).

Variable Pelvic Area With:	Correlation	Standard Partial Regression Coefficients
Body weight	.53**	.32**
Rump length	.50**	.18*
Hip width	.52**	.25**

* $P < .05$

** $P < .01$

A highly significant amount of pelvic area variation can be due to body weight, but when body weight was held constant and the direct effects of hip width and rump length studied with full allowance made for their indirect effects acting through body weight, the variation can be due to hip and rump variables. Skeletal measurements or size (hip and rump) were more closely related to pelvic area due to the fact all three were skeletal in structure. Larger skeletal size was indicative of larger pelvic area, Bellows et al. (Undated).

Lefever (Undated. Unpublished mimeograph material, U. of Wyom., Laramie.), using Hereford heifers calving as 2 year olds, showed that of 43 of the heifers that had an average pelvic area of 175.3 sq. cm. 28% calved with no trouble, 18% required assistance, 41% required the use of pullers, and 13% required a

Caesarean, additional assistance with pullers, or a veterinarian was needed. The size of the pelvic opening does not predict all of the heifers which will have parturition problems, but there was a strong tendency for heifers with larger pelvic openings to have less parturition dystocia. Heifers which have pelvic openings greater than 200 sq. cm. should have no difficulty or very little at parturition if the presentation is normal, Lefever (Undated. Unpublished mimeograph material, U. of Wyom., Laramie.).

Calf losses at birth for heifers with small pelvic openings were twice as great as heifers with large pelvic openings, Lefever (Undated. Unpublished mimeograph material, U. of Wyom., Laramie.).

The calving difficulty scores or classification values for the following tables were:

1 - no trouble

2 - assistance given

3 - pullers needed

4 - Caesarean, additional assistance with pullers, or veterinarian needed

Table 1

Information on Calves From Two-Year-Old Hereford Heifers, Lefever (Undated. Unpublished mimeograph material, U. of Wyom., Laramie.)

Pelvic Opening of Heifers	No. of Head		No. Died at Birth		No. of Caesarean	Avg. Birth Wt.	Avg. Birth Weight by Calving Classification			
	M	F	M	F			1	2	3	4
Less than 190 sq. cm.	18	25	5	3	3	62	58.5	62.6	63.2	66.4
More than 190 sq. cm.	21	12	3	0	0	66	63.1	67.5	78.0	76.0

Table 2

Effect of Birth Weight on Calving Difficulty in Two-Year-Old Heifers*, Lefever (Undated. Unpublished mimeograph material, U. of Wyom., Laramie.)

Birth Wt. (lb.)	No. of Calves	% Calving Difficulty			
		1	2	3	4
Less than 55	5	80	20	--	--
55 - 59	7	57	14	29	--
60 - 64	24	38	29	29	4
65 - 69	22	50	14	22	14
70 - 74	6	17	17	33	33
More than 74	5	--	40	40	20

*Only calves in normal presentation at birth were used.

The relationship between size of pelvic opening and calving difficulty was found to be higher than weight of calf and calving difficulty, Lefever (Undated. Unpublished mimeograph material, U. of Wyom., Laramie.).

EXPERIMENTAL METHODS

Animal History

Eighty-two choice grade Hereford heifer calves were used in this experiment. The heifers were obtained from two herds in Kansas; 42 heifers were from the Meinhart ranch at Saint Marys, and the remaining 40 heifers were obtained from the Ferrell ranch at Beaumont. The heifers were about 9 months old, healthy, and in medium flesh when started on experiment December 18, 1965.

Treatment Distribution

The heifers were weighed December 17, 1965, and reweighed December 18, 1965. The average of the two weights was used as the initial starting weight.

The 42 Meinhart heifers were allotted randomly into three lots; No. 1, 2, and 3. Fourteen heifers were allotted to each lot. The 40 Ferrell heifers were allotted randomly into three lots; No. 4, 5, and 6 of 14, 13 and 13 heifers respectively.

Lots No. 1 and 4 were assigned the No. 1 supplemental ration, lots No. 2 and 5 were assigned the No. 2 supplemental ration, and lots No. 3 and 6 were assigned supplemental ration No. 3. The supplemental rations are described in the following paragraph.

Nutritional Treatment

The nutritional phase of this experiment consisted of a comparison of two supplements for feeding on winter bluestem pasture and the value of delaying energy feeding until the latter part of the winter period. The total amount of supplemental protein and energy received was the same for all treatments, only the source of protein and time of feeding energy varied. The following three supplemental rations were fed each winter for two winters and were formulated on a per head/day basis. Ration No. 1 consisted of 1 lb. of soybean meal (46% protein) and 2 lb. of sorghum grain (10% protein). Ration No. 2 was comprised of 3.3 lb. of dehydrated alfalfa meal (17% protein) and 1 lb. of sorghum grain. Ration No. 3 was identical to ration No. 1 except the soybean meal was fed at the rate of 1.5 lb. per heifer daily the first two-thirds of each winter period, and all the sorghum grain was fed the last one-third of the winter period at the rate of 6.5 lb. per heifer daily.

The feeding regime is indicated below, as is the analysis of the daily nutrient intake supplied by the supplemental rations. For ration analysis and nutrient requirements see Tables 3, 4, and 5.

The first winter of supplemtation, ration No. 1 was fed for 132 days, from December 18, 1965, to April 30, 1966. The protein level was 0.66 lb. and the TDN level was 2.40 lb. Ration No. 2 was fed for 132 days, from December 18,

Table 3

Winter Supplemental Ration Analysis*

	Ration No. 1		Ration No. 2		Ration No. 3			
	12/18/65-4/30/66	10/24/66-4/20/67	12/18/65-4/30/66	10/24/66-4/20/67	12/18/66 - 4/30/66		10/24/66 - 4/20/67	
					First 96 Days	Last 36 Days	First 114 Days	Last 65 Days
Protein	0.66	0.66	0.66	0.66	0.69	0.67	0.69	0.63
TDN	2.40	2.40	2.45	2.45	1.20	5.32	1.20	5.04
Phosphorous	0.021	0.021	0.021	0.021	0.019	0.028	0.019	0.027
Calcium	0.004	0.004	0.045	0.045	0.005	0.089	0.005	0.085
Vitamin A	20,000 IU	20,000 IU	20,000 IU	20,000 IU	20,000 IU	20,000 IU	20,000 IU	20,000 IU

*Values given are on a lb. basis per head/day.

Table 4

NRC Requirements for Wintering Yearling Cattle*
NRC (1963)

Digestible protein	.72
TDN	7.15
Phosphorous	.024
Calcium	.029
Vitamin A	750 IU

*Requirements for heifers for the first winter of supplemental feeding/lb./head/day.

Table 5

NRC Requirements for Wintering Pregnant Heifers*
NRC (1963)

Digestible protein	.90
TDN	10.00
Phosphorous	.030
Calcium	.032
Vitamin A	1000 IU

*Requirements for heifers for the second winter of supplemental feeding/lb./head/day.

1965, to April 30, 1966. The protein level was 0.66 lb. and the TDN level was 2.45 lb. Ration No. 3 varied in that 1.5 lb. of soybean meal was fed for the first 96 days. The protein level available was 0.69 lb. and the TDN level was 1.20 lb. for the first 96 day period. The last 36 days of the feeding period 6.65 lb. of sorghum grain only was fed. The protein level available was 0.67 lb. and the TDN level was 5.32 lb.

The second winter of supplemental feeding, ration No. 1 was fed for 179 days, from October 24, 1966, to April 20, 1967. The protein level was 0.66 lb. and the TDN level was 2.40 lb. Ration No. 2 was fed for 179 days, from October 24, 1966, to April 20, 1967. The protein level was 0.66 lb. and the TDN level was 2.45 lb. Ration No. 3 varied in that 1.5 lb. of soybean meal was fed for the first 114 days of the feeding period. The protein level available was 0.69 lb. and the TDN level was 1.20 lb. The remaining 65 days 6.3 lb. of sorghum grain only was fed. The protein level was 0.63 lb. and the TDN level was 5.04 lb. During the second winter supplemental feeding period, the heifers were grouped together on February 22, 1967, when the calving season started. The heifers were separated each feeding by lots into the three ration treatments and then regrouped after each feeding.

The heifers had salt and fresh water available ad libidum. During both winter supplemental feeding periods all three rations contained monosodium phosphate and Vitamin A. Each heifer received 0.05 lb. of monosodium phosphate and 20,000 IU of Vitamin A/day.

Throughout all phases of the experiment the heifers were grazed on limestone breaks and upland pastures consisting of native bluestem grasses. The heifers were grazed on the Grass Utilization Unit, Kansas State University, Manhattan, Kansas. There was an adequate amount of bluestem grasses available the first winter, and no supplemental feeding of roughage was required.

The grass was not as plentiful during the second winter feeding period, and some prairie hay was fed during a period when snow rendered the bluestem pasture unavailable. The shortage of pasture the second winter was due to a very dry spring and late summer moisture. Even though the grass wasn't as plentiful, the quality appeared to be high. The differences between the NRC requirements and the actual values supplied by the supplemental rations in regard to protein and TDN were expected to be supplied by the native bluestem pasture grasses.

Lots No. 1, 2, and 3 were pastured together in a 190 acre pasture and lots No. 4, 5, and 6 were each allotted to a 63, 60, and 60 acre pasture respectively. Lots No. 1, 2, and 3 were penned according to lot number each feeding during the winter supplemental feeding phase and then regrouped after feeding. Lots No. 4, 5, and 6 were fed their winter supplements in their respective pastures.

The heifers were maintained in their specific pastures until the breeding and calving seasons commenced when they were turned together.

Hormone Treatment

Six heifers from each lot (No. 1, 2, 3, 4, 5, and 6) were randomly selected and implanted subcutaneously in the ear with 15 mg. of DES at the start of the experiment on December 18, 1965.

On March 26, 1966, three heifers randomly selected from each group of six heifers that were implanted December 18, 1965, were reimplanted with 15 mg. of DES.

Weighing Procedures

The heifers were weighed by treatment lots approximately every 30 days except during the calving season from February 22, 1967, to May 29, 1967, when weights were too variable to be valid. The heifers were penned by lots the night prior to weighing the following morning. No feed or water was available to the heifers during their overnight stand in order to equalize fill variables. The heifers were weighed individually to the nearest 5 lb.

The birth weights of the calves were obtained by weighing the calves no later than 12 hours after birth. The calves were weighed in the pasture using a holding sack and a portable hand scale. The calves were weighed to the nearest 1 lb. The calves were tagged with identity numbers and tattooed at the time of weighing.

Breeding Management

The heifers were bred naturally at an average weight of approximately 530 lb. The heifers were grouped together and the bulls turned in with them in a 139 acre pasture May 16, 1966.

Four purebred Angus bulls of medium size and frame were used due to the size of the heifers which were being bred to calve as 2 year olds. The bulls ran with the heifers in the same pasture until July 10, 1966; then the heifers were separated randomly and placed into three pastures with one bull in each pasture until August 2, 1966, at which time the bulls were removed. The heifers were regrouped and returned to their respective pastures at the termination of the breeding season.

The heifers were pregnancy examined September 22, 1966, and returned to their pastures. At this time no heifers were culled if diagnosed open by the pregnancy examination.

The heifers were grouped together when the calving season started February 22, 1967, and they calved under range conditions in a 139 acre pasture. The heifers were ridden and checked for calving difficulty at least four times a day. The heifers were normally checked at 7 a.m., 3 p.m., 6 p.m., and between 11 and 12 p.m. Any heifer which displayed evidence of possibly calving during the night was penned at the 6 p.m. check and checked again that night between 11 and 12 p.m. Due to pasture terrain, it was impossible to check the heifers at night while in the pasture.

If at any time a heifer was observed showing evidence of calving difficulty, she was brought to a holding pen and assistance rendered if necessary.

The heifers were scored on calving difficulty using the following scale:

1 - no assistance rendered

2 - assistance required

3 - pullers or additional assistance required

4 - veterinarian or Caesarean required

The heifers were left pastured together after termination of the calving season. The same four Angus bulls used for the first breeding season were turned in with the heifers on May 13, 1967. Soon after the bulls were turned with the heifers, one of the bulls suffered a broken leg, apparently from fighting, and had to be destroyed.

Determination of Pelvic Opening Area and Hook Width

The pelvic girdles were measured intra-rectally using an instrument designed and built by the author after a model designed by Dr. Edmund J. Krautmann, D.V.M., Chillicothe, Missouri. The instrument was constructed of smooth 5/8 steel rod and the ends were ground smooth to prevent damage to the sensitive epithelial lining.

The instrument required two operators. One operator guided the instrument, intra-rectally, to the desired position on the pelvic girdle. The other operator manipulated the opening and closing of the instrument which has a pivot point near the middle of two bars and allows the internal segment to expand to the width or height of the pelvic opening. The operator manipulating the instrument from the outside has complete control of the pressure applied, direction, and angle of use. The operator working intra-rectally guides the instrument to the desired position and instructs the outside operator as to pressure or angle desired.

The actual measurement is taken by the outside operator who spreads the bars to the desired width, and then using a metric scale, determines the distance between the outside bars which corresponds to the width at the desired point in the pelvic opening, see Figure 1.

The width of the pelvic girdle opening was measured at a point approximately in the middle of the shafts of the ilium. The point of orientation used by the author was the cranial edge of the shafts of the ilium, see Figure 2. The height of the pelvic opening was determined by measuring the points between the dorsal ridge of the symphysis pubis and going vertically to the sacral promontory (junction of the first and second sacral vertabrae) see Figure 3. The height is easy to determine and the point of orientation used by the author was the ridge or rise formed by the symphysis pubis. The slope of the pelvic girdle lies approximately on a 45° angle with the dorsal cranial edge being forward, see Figure 4. When measuring the height, the operator needs to compensate for this angle and adjust the angle of the instrument to somewhat the same angle.

The pelvic opening is oblong and a true area is difficult to determine under the present techniques. The area was determined by multiplying the width value times the height value. The resulting value is the pelvic opening area expressed in sq. cm.

The heifers' pelvic areas were determined from measurements taken November 25, 1966, approximately 3 months prior to parturition. The heifers were measured

Fig. 1. Illustrates the instrument used to obtain the pelvic girdle opening measurements. The solid lines denote a closed position.

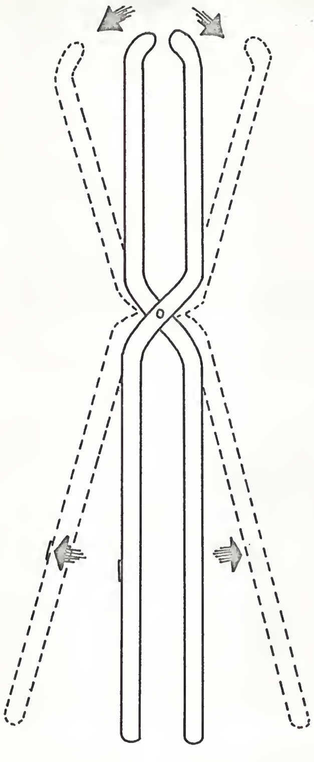
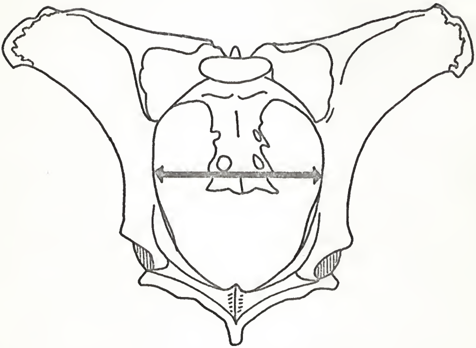
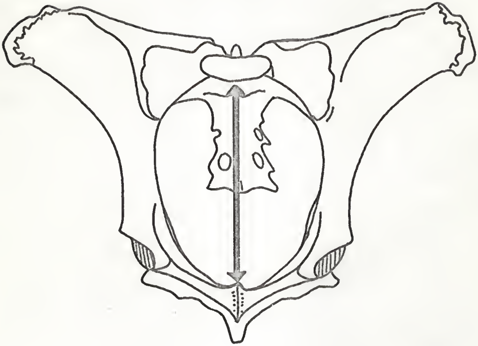


Fig. 2. Illustrates the position on the pelvic girdle (shafts of the ilium) where the width of the pelvic opening was determined.



Sisson (1963)

Fig. 3. Illustrates the points of orientation used in determining the height of the pelvic girdle opening. The points of orientation were the symphysis pubis and the junction of the first and second sacral vertabrae.



Sisson (1963)

Fig. 4. Illustrates the position and angle formed by the pelvic girdle in relation to the bovine skeletal structure.

Sisson (1963)

in a squeeze chute with the rear gate removed. The author found measurements were obtained with greater ease when the heifers were not squeezed tight and their heads left unrestrained. To prevent the heifers from backing out of the chute, a bar was placed across the chute about 8 inches above the heifers' hocks.

Care must be taken when expanding the instrument in the pelvic girdle so that no trauma is inflicted upon the epithelial lining of the large intestine due to peristaltic activity. In order to avoid unnecessarily entering the tract for both measurements, the instrument was manipulated in the closed position after determination of the width and rotated 90^{o} and expanded again to measure the height of the opening.

The instrument used and technique involved resulted in only a few heifers suffering mild trauma and hemorrhaging of the epithelial lining of the large intestine.

The hook width was obtained by measuring the distance between the tuber coxae using a large outside caliper, see Figure 5. The points of orientation used in determining the hook width were the cranial edge midpoint of the tuber coxae, see Figure 6. Pressure was applied at the point of measurement to compensate for variation between individuals in regard to degree of finish or fleshing covering the tuber coxae. The heifers were measured unrestricted in a squeeze chute.

STATISTICAL ANALYSIS

The data obtained from the 82 Hereford heifers and their progeny was analyzed using a three way least squares and regression program, Harvey (1960). The statistical analysis was obtained by using an IBM 1410 computer.

To determine significance of the data obtained, an F-test was used at the .05, .01, and .001 levels. To determine significance within a subclass a T-test was used.

Fig. 5. Illustrates the type of outside caliper used in determining hook width.

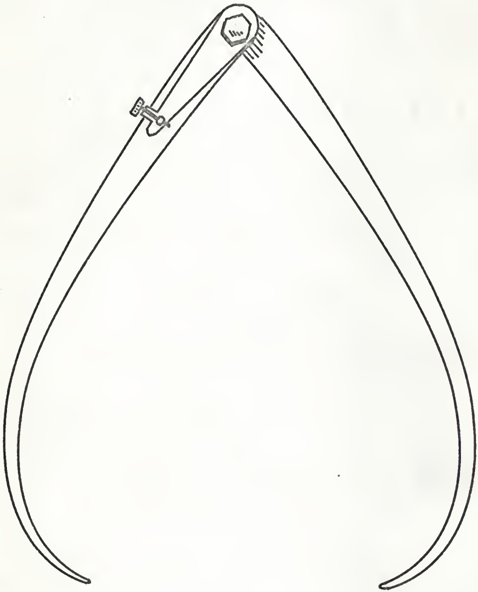
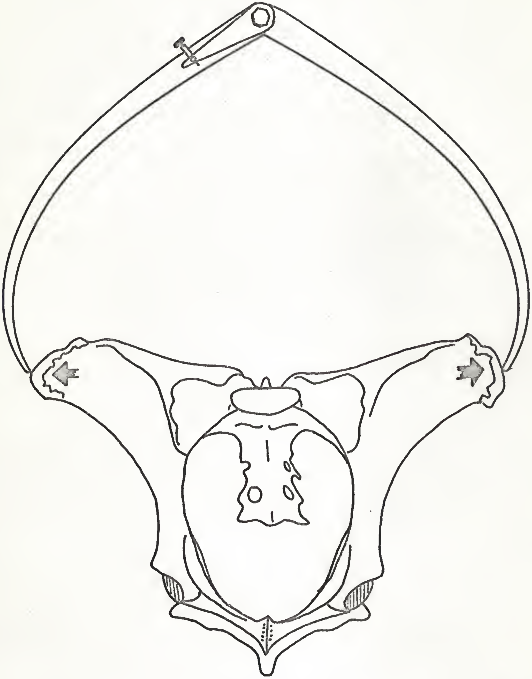


Fig. 6. Illustrates the position of the outside caliper on the tuber coxae for determination of the hook width.



Sisson (1963)

RESULTS AND DISCUSSION

Pelvic Girdle Area

The pelvic girdle area pure mean, that is the pelvic girdle area without the influence of hormone and nutrition treatments, source, or body weight, was 170.46 sq. cm., see Table 6. The hormone treatment effect was not significant at the 5 percent level. The non implanted group (control) had the greatest deviation from the mean, 3.42 $\pm$ 2.89 sq. cm., while the single implant level had the least deviation from the mean, -1.05 $\pm$ 3.67 sq. cm. The results also indicated that the nutritional treatments were non significant at the 5 percent level. Ration No. 3 resulted in a deviation from the mean of -6.00 $\pm$ 3.85 sq. cm. while ration No. 2 indicated a deviation from the mean of 5.46 $\pm$ 3.48 sq. cm. Ration No. 1 was least effective in varying pelvic girdle area having a deviation from the mean of only .54 $\pm$ 3.36 sq. cm.

The source of the heifers was significant ($P < .05$) in regard to pelvic girdle area. The Meinhart heifers deviation from the mean was 5.51 $\pm$ 7.57 sq. cm. while the Ferrell heifers deviation from the mean was -5.51 $\pm$ 7.57 sq. cm., see Table 6.

The heifers body weight significantly ($P < .05$) affected the pelvic girdle area; the heavier heifers were probably slightly older and therefore more mature in regard to skeletal development. There might also be inherent genetic factors that influenced pelvic girdle area. If a correlation existed between pelvic girdle area and hook width, the producer could measure the distance between the hooks and have some insight as to the pelvic girdle area without actually having to make this measurement. However, according to the analysis of the data, there was no significant correlation between hook width and pelvic girdle area. The correlation between hook width and pelvic girdle opening was .082 with a correlation of .205 between pelvic girdle opening and body weight, see Table 13.

Table 6

Effect of Characteristics on Pelvic Girdle Area

Characteristics	F-Test	No. of Observ.	Pelvic Girdle Area Deviation From Mean sq. cm.
Mean - 170.46 sq. cm.		82	
Hormone Treatment	Non sig.		
Single Implant		18	-1.05 ± 3.67
Reimplanted		18	-2.37 ± 3.60
Control		46	3.42 ± 2.89
Nutrition Treatment	Non sig.		
Ration No. 1		28	.54 ± 3.36
Ration No. 2		27	5.46 ± 3.48
Ration No. 3		27	-6.00 ± 3.85
Source	$P < .05$		
Meinhart		42	5.51 ± 7.57
Ferrell		40	-5.51 ± 7.57
Dams Body Weight	$P < .05$	82	.17 ± .31
Hook Width	Non sig.	82	- .92 ± .07
No significant interactions			

There was no significant interaction between hormone x nutrition, hormone x source, or nutrition x source in regard to pelvic girdle opening.

The data from this project was not in agreement with the work of Walker (1961). The results of this study show that DES had no significant effect in increasing the pelvic girdle opening. Walker (1961) indicated that steers reimplanted with 24 mg. of DES after an initial implant of 24 mg. of DES had larger pelvic girdle openings than the single implant steers, and the single implant steers had larger pelvic girdle openings than the control group. In this study using 15 mg. of DES just the opposite results were obtained, see Tables 6 and 11.

Bellows et al. (Undated) indicated that a correlation of .52 ($P < .01$) was found between pelvic girdle opening and hook width. Also a correlation of .53 ($P < .05$) existed between pelvic girdle area and body weight. The statistical analysis of this data failed to show significant correlations, see Table 13.

Hook Width

The pure hook width mean was 30.96 cm., refer to Table 7. The hormone treatments were non significant at the 5 percent level in their effect on hook width. The single implant had a deviation from the mean of $-.4378 \pm .2328$ cm., while the reimplanted groups deviation from the mean was $.3924 \pm .2304$ cm.

The control group had the least effect having a deviation from the mean of only $.0454 \pm .1903$ cm.

The nutritional treatments were also non significant at the 5 percent level in altering hook width. Ration No. 2 had the most effect causing a deviation from the mean of $-.5265 \pm .2218$ cm. while ration No. 1 and ration No. 3 produced a deviation from the mean of $.3153 \pm .2156$ cm. and $.2112 \pm .2217$ cm. respectively.

Table 7

Effect of Characteristics on Hook Width

Characteristics	F-Test	No. of Observ.	Hook Width Deviation From Mean, cm.
Mean - 30.96 cm.		82	
Hormone Treatment	Non sig.		
Single Implant		18	-.4378 ± .2328
Reimplanted		18	.3924 ± .2304
Control		46	.0454 ± .1903
Nutrition Treatment	Non sig.		
Ration No. 1		28	.3153 ± .2156
Ration No. 2		27	-.5265 ± .2218
Ration No. 3		27	.2112 ± .2217
Source	Non sig.		
Meinhart		42	-.0916 ± .1625
Ferrell		40	.0916 ± .1625
Dams Body Weight	$P < .001$	82	.0255 ± .0038
Pelvic Girdle Opening	Non sig.	82	-.0039 ± .0083
Interactions			
Hormone x Nutrition	$P < .05$		
Single Imp. - Ration 1		6	.5256 ± .3308[c]
Single Imp. - Ration 2		6	.4548 ± .3254[c]
Single Imp. - Ration 3		6	-.9804 ± .3365[b]
Reimplanted - Ration 1		6	.1971 ± .3270[acde]
Reimplanted - Ration 2		6	-.4666 ± .3253[abe]
Reimplanted - Ration 3		6	.2695 ± .3282[cd]
Control - Ration 1		16	-.7227 ± .2648[ab]
Control - Ration 2		15	.0118 ± .2693[acde]
Control - Ration 3		15	.7109 ± .2704[c]
Nutrition x Source	~sig.		
Ration 1 - Meinhart		14	.3664 ± .2168[ab]
Ration 1 - Ferrell		14	-.3664 ± .2168[cd]
Ration 2 - Meinhart		14	.1895 ± .2230[be]
Ration 2 - Ferrell		13	-.1895 ± .2230[ce]
Ration 3 - Meinhart		14	-.5559 ± .2274[d]
Ration 3 - Ferrell		13	.5559 ± .2274[a]

*All values with the same superscripts are not significantly different at the 5 percent level.

The source of the cattle had no significant effect on the hook width; deviation from the mean was only $\pm$ .0916 cm. The results of this study indicated that the most significant ($P < .001$) effect on hook width was due to body weight. The heavier heifers had more width between their hooks. Probably the main effect of body weight was the degree of fleshing over the tuber coxae which influenced measurements of the hook width. There may also be some variance between individuals in regard to hide thickness which in itself would influence hook width. The correlation between hook width and body weight was .575, see Table 13.

There was no significance at the 5 percent level between hook width and pelvic girdle area. The pelvic girdle area deviation from the mean was -.0039 $\pm$ .0083 cm.

The interaction between hormone and nutrition treatments was significant at the 5 percent level, and the nutrition source interaction approached significance at the 5 percent level, see Table 7.

The interaction between the single implant level and ration No. 3 had the most effect on hook width with a deviation from the mean of -.9804 $\pm$ .3365 cm. while the control hormone level and ration No. 2 had the least effect on hook width with a deviation from the mean of .0118 $\pm$ .2693 cm. The other hormone and nutrition interaction deviations from the mean lie between the single implant x ration No. 3 and control x ration No. 2 values, see Table 7.

The interaction between the nutrition treatments and the source of the heifers approached significance with ration No. 3 and the Ferrell heifers having a deviation from the mean of .5559 $\pm$ .2274 cm. The other interaction values were progressively lower with ration No. 3 and the Meinhart heifers having a deviation from the mean of -.5559 $\pm$ .2274 cm.

Dams Body Weight

The heifers were weighed just prior to turning in the bulls and the statistical analysis was based on this weight. This weight just prior to breeding was used due to the influences of gestation and lactation at later weigh periods.

The data showed no significant influence on dams body weight at the 5 percent level for any treatment. This lack of significance was probably due to a rather large mean square error caused mainly by not being able to adjust for the age variance between heifers.

The single implant had a deviation from the mean of 7.42 $\pm$ 5.85 lb. with the reimplanted and control groups having a deviation from the mean of -4.30 $\pm$ 6.33 lb. and -3.11 $\pm$ 5.55 lb. respectively, see Table 8.

Ration No. 1 had the least effect on the dams body weight of any treatment, having only a -0.43 $\pm$ 5.48 lb. deviation from the mean. The most response due to nutritional treatment was found in ration No. 2 with a deviation from the mean of 5.16 $\pm$ 5.87 lb.

The factor having the most influence on deviation from the mean was source, with the Ferrell heifers having a deviation from the mean of 8.91 $\pm$ 5.48 lb., while the Meinhart heifers had a deviation from the mean of -8.91 $\pm$ 5.48 lb. If it were possible to evaluate the heifers body weight with regard to actual age, some significance between sources may have been realized.

Changes in Conformation

The changes in conformation due to hormone treatment were not uniform. Several of the single implanted heifers and also the reimplanted heifers displayed noticeable changes in mammary gland development as well as changes in the loin, tail head, and rump area. The DES caused an increase in teat length,

Table 8

Effect of Characteristics on Dams Body Weight*

Characteristics	F-Test	No. of Observ.	Dams Body Weight Deviation From Mean, lb.
Mean - 499.32 lb.		82	
Hormone Treatment	Non sig.		
Single Implant		18	7.42 ± 5.85
Reimplanted		18	-4.30 ± 6.33
Control		46	-3.11 ± 5.55
Nutrition Treatment	Non sig.		
Ration No. 1		28	-0.43 ± 5.48
Ration No. 2		27	5.16 ± 5.87
Ration No. 3		27	-4.73 ± 9.73
Source	Non sig.		
Meinhart		42	-8.91 ± 5.48
Ferrell		40	8.91 ± 5.48
No significant interactions			

*Data calculated on the dams weight recorded just prior to when the bulls were turned in with the heifers.

a rising of the tail head, and some of the heifers appeared to have a lowering or relaxation of the muscling in the area of the loin. Several heifers soon after implantation displayed varying degrees of turgidity of the vulva. There were no observed incidences of prolapsed uteruses or riding due to the implantation with DES.

The changes in conformation became less apparent as the test progressed; in fact, after several months it was difficult to accurately distinguish between treatment groups on the basis of conformation changes alone.

Reproduction

The heifers were pregnancy checked, and the mean percentage of the heifers bred was 87.80, see Table 9.

The reimplanted group had 72.22% of the heifers diagnosed pregnant. The single and control groups had diagnosed pregnancy levels of 83.33% and 95.65% respectively.

The nutritional treatments had less variation in the percentage of the heifers diagnosed pregnant. Ration No. 1 had the highest percent of the heifers bred with a conception rate of 89.29%, while ration No. 2 and ration No. 3 had conception rates of 85.19% and 88.89% respectively.

The Ferrell heifers had a 4.29% higher conception rate than the Meinhart heifers, see Table 9.

The hormone, nutrition treatments, and source weren't too different from the mean conception rate with the exception of the reimplanted group with a 72.22%. The real variance was found in the interactions between the hormone, nutrition treatments, and source.

The interaction between hormone treatment and nutrition treatments was largest in regard to deviation from the mean. The single implant-ration No. 1,

Table 9

Relationship Between Characteristics and
Conception Rate, Birth Weight, and Sex of Calf

Characteristics	No. of Observ.	Dams Wt. (5/2/66)	% Heifers Diagnosed Pregnant	% Heifers That Calved	% Live Calves Per Heifer Bred	Avg. Calf Birth Wt.	% Calves Bulls	% Calves Heifers
Mean	82	499.00	87.80	84.15	75.61	60.51	51.47	48.53
Hormone Treatment								
Single Implant	18	511.94	83.33	72.22	66.67	62.31	53.85	46.15
Reimplanted	18	494.67	72.22	66.67	55.56	61.92	66.67	33.33
Control	46	491.09	95.65	95.65	86.96	59.58	46.51	53.49
Nutrition Treatment								
Ration No. 1	28	495.89	89.29	85.71	75.00	60.71	41.67	58.33
Ration No. 2	27	498.33	85.19	77.78	66.67	61.55	75.00	25.00
Ration No. 3	27	494.81	88.89	88.89	85.19	59.46	41.67	58.33
Source								
Meinhart	42	488.81	85.71	78.57	71.43	61.63	56.25	43.75
Ferrell	40	504.25	90.00	87.50	77.50	59.53	47.22	52.78

Table 9 continued on Page 48.

Table 9 (Continued)

Characteristics	No. of Observ.	Dams Wt. (5/2/66)	% Heifers Diagnosed Pregnant	% Heifers That Calved	% Live Calves Per Heifer Bred	Avg. Calf Birth Wt.	% Calves Bulls	% Calves Heifers
Mean	82	499.00	87.80	84.15	75.61	60.51	51.47	48.53
Interactions								
Hormone x Nutrition								
Single Imp.-Ration 1	6	495.00	100.00	83.33	83.33	62.40	40.00	60.00
Single Imp.-Ration 2	6	523.33	50.00	33.33	33.33	65.00	100.00	-
Single Imp.-Ration 3	6	515.83	100.00	100.00	83.33	61.33	50.00	50.00
Reimplanted-Ration 1	6	491.67	66.67	66.67	50.00	65.00	75.00	25.00
Reimplanted-Ration 2	6	495.00	100.00	83.33	66.67	64.60	80.00	20.00
Reimplanted-Ration 3	6	497.50	50.00	50.00	50.00	53.33	33.33	66.67
Control-Ration 1	16	497.81	93.75	93.75	81.25	59.00	33.33	66.67
Control-Ration 2	15	489.67	93.33	93.33	86.67	59.85	69.23	30.77
Control-Ration 3	15	485.33	100.00	100.00	93.33	59.93	40.00	60.00
Hormone x Source								
Single Imp.-Meinhart	9	506.67	88.89	66.67	55.56	64.67	66.67	33.33
Single Imp.-Ferrell	9	516.11	77.78	77.78	77.78	60.29	42.86	57.14
Reimplanted-Meinhart	9	478.33	55.56	44.44	33.33	68.50	75.00	25.00
Reimplanted-Ferrell	9	511.11	88.89	88.89	77.78	58.63	62.50	37.50
Control-Meinhart	24	485.63	95.83	95.83	91.67	59.55	50.00	50.00
Control-Ferrell	22	496.59	95.45	95.45	81.82	59.62	42.86	57.14
Nutrition x Source								
Ration 1 - Meinhart	14	494.29	85.71	78.57	78.57	61.00	27.27	72.73
Ration 1 - Ferrell	14	497.50	92.86	92.86	71.43	60.46	53.85	46.15
Ration 2 - Meinhart	14	489.64	85.71	71.43	57.14	63.78	77.78	22.22
Ration 2 - Ferrell	13	507.69	84.62	84.62	84.62	59.73	72.73	27.27
Ration 3 - Meinhart	14	482.50	85.71	85.71	78.57	60.58	66.67	33.33
Ration 3 - Ferrell	13	508.08	92.31	92.31	84.62	58.33	16.67	83.33

single implant-ration No. 3, reimplanted-ration No. 2, and control-ration No. 3 all had 100% conception rates by diagnosis. Control-ration No. 1 and control-ration No. 2 had conception rates of 93.75% and 93.33% respectively. The reimplanted-ration No. 1 treatment resulted in a conception rate of 66.67%, while the lowest conception in the study was found with the single implant-ration No. 2 and reimplanted-ration No. 3, both having a 50% conception rate.

The hormone treatment and source interaction indicated the control treatment had a 95.60% conception rate with the single implant and reimplanted groups having a 83.33% and 72.23% conception rate respectively. When all three hormone treatments were compared by source, the Ferrell heifers had 87.00% conception while the Meinhart heifers had 80.09% conception, see Table 9.

The nutritional treatment interaction with source in the Ferrell heifers showed a 89.93% conception rate versus only 85.71% for the Meinhart heifers.

In a comparison of the heifers diagnosed pregnant versus their actual calving percent, the following data was collected, see Table 9.

The heifers in the single implant group had 11.11% less pregnancies than indicated by diagnosis; the reimplanted group was 5.55% lower. However, the control group remained unchanged at 95.65%.

The same condition found in the hormone treatment existed in the nutritional treatment. The actual calving percentages of ration No. 1 and ration No. 2 were 3.58% and 7.41% lower respectively. There was no change in conception rate between the diagnosed pregnant percentage and actual calving percent in regard to ration No. 3.

The Meinhart and Ferrell heifers actual calving percentages were 7.14% and 2.50% lower respectively than previously indicated by pregnancy diagnosis, see Table 9.

In regard to the interaction between hormone and nutritional treatments, the data indicated that the single implant-ration No. 1, single implant-ration No. 2, and reimplanted-ration No. 2 conception rates were all reduced 16.67%.

The single implant-Meinhart heifers showed a reduction of 22.22% in conception from diagnosed pregnant and actual calving percent. The reimplanted-Meinhart heifers also showed a loss of 11.12% in respect to the diagnosed pregnant values. However, the other hormone-source interactions remained unchanged between diagnosed pregnant and actual calving percent.

The results indicated that the ration No. 1-Meinhart heifers showed a loss of 13.14% between diagnosed conception rate and actual calving percent. Ration No. 2-Meinhart heifers also displayed a reduction in conception of 14.28%.

There appears to be some physiological action caused by the implantation of DES either in a single implant of 15 mg. or even more clearly in the reimplantation of 15 mg. of DES in regard to reducing the pregnancies going to term. Possibly the high levels of exogenous estrogen present during pregnancy caused a hormonal imbalance and abortion or resorption of the fetus. Or it could be due to interference with normal placentation due to uterine contractions stimulated by the presence of DES.

There is no doubt that the data presented indicated a reduction in the percentage of the heifers implanted with DES that completed pregnancy and calved. This indicates that the use of DES for breeding females too close to the breeding season is detrimental and economically unsound. Even though the single implanted heifers had heavier calves with far less calving difficulty at birth, this is overshadowed by the reduction in percent live calves per heifer bred, see Table 9.

The results of this study are in agreement with Wickersham and Schultz (1964) in that conception is reduced considerably with heifers implanted or fed

DES. The data presented in this paper is in disagreement with the results of Bush and Reuber (1963) who indicated that feeding dairy heifers 15 mg. of DES a day from 4 months to 15 months of age had no effect on their ability to conceive and produce a normal calf. The results of this study clearly show a marked reduction in conception rate and calving percentage when beef heifers were implanted with 15 mg. of DES.

Calf Birth Weight

The hormone treatments had no significant effect on calf birth weight at the 5 percent level. The single implant and reimplanted treatments had a positive effect on birth weight having deviations from the mean of 0.945 ± 1.619 lb. and 0.721 ± 0.483 lb. respectively. The control heifers had a deviation from the mean of -1.666 ± 1.206 lb., see Table 10.

The nutrition treatments also had no significant effect at the 5 percent level. Ration No. 1 had the most effect with a deviation from the mean of 1.892 ± 1.444 lb. Rations No. 2 and 3 had deviations from the mean of 0.578 ± 1.619 lb. and -2.470 ± 0.981 lb. respectively.

The source of the dams had a significant ($P < .05$) effect on birth weight. The Meinhart heifers calves were heavier than the calves from the Ferrell heifers. The Meinhart heifers calves had a deviation from the mean of 2.136 ± 0.981 lb. while the Ferrell heifers calves deviation from the mean was -2.136 ± 0.981 lb.

The sex of the calves had a significant ($P < .05$) effect on birth weight. The bull calves averaged about 8.88 lb. heavier than the heifer calves with a deviation from the mean of 2.253 ± 1.107 lb., see Table 10.

The results of this experiment indicated a correlation of .25 between date of birth and birth weight. Also, a correlation of .26 was found between birth weight and dams weight, see Table 13.

Table 10

Effect of Characteristics on Calf Birth Weight

Characteristics	F-Test	No. of Observ.	Calf Birth Weight Deviation From Mean lb.
Mean - 61.42 lb.		68	
Hormone Treatment	Non sig.		
Single Implant		13	0.945 ± 1.619
Reimplanted		12	0.721 ± 0.483
Control		43	-1.666 ± 1.206
Nutrition Treatment	Non sig.		
Ration No. 1		24	1.892 ± 1.444
Ration No. 2		20	0.578 ± 1.619
Ration No. 3		24	-2.470 ± 1.450
Source	$P < .05$		
Meinhart		32	2.136 ± 0.981
Ferrell		36	-2.136 ± 0.981
Sex	$P < .05$		
Bull Calves		35	2.253 ± 1.107
Heifer Calves		33	-2.253 ± 1.107

Interactions were non significant

The heifers in the ration No. 1 group had 20.83% of their calves pulled with an average birth weight of 63.60 lb. and a calving difficulty score of 1.04. Both the ration No. 2 and ration No. 3 heifers had 25.00% of their calves pulled with an average birth weight of 65.20 lb. and 66.50 lb. respectively. The calving difficulty score for ration No. 2 was 1.07 and for ration No. 3 was 1.22, see Table 11.

The Meinhart heifers had 33.33% of their calves pulled versus only 13.89% of the Ferrell heifers calves pulled. The average weight of the Meinhart calves that were pulled was 65.46 lb. with a calving difficulty score of 1.48. The average weight of the Ferrell heifers calves that were pulled was 64.60 lb. with a calving difficulty score of only 1.17.

The percentage of calves pulled, birth weight, and calving difficulty scores for the interaction groups are listed in Table 11. For convenience they were not listed separately in this section but can be referred to in the table indicated.

It was apparent that the sex of the calf influenced birth weight. The bull calves had an average birth weight of 66.79 lb. versus only 57.91 lb. for the heifer calves, see Table 11. The data showed that 37.14% of the bull calves required pulling while only 9.09% of the heifer calves were pulled. The calving difficulty score for the bull calves was 1.54 and only 1.09 for the heifers. The correlation between the sex of the calf and requiring pulling or not requiring pulling was .332, while the correlation between sex of the calf and calving difficulty score was -.361, see Table 13. The calf birth weight had a correlation of -.379 in regard to requiring pulling or not and a correlation of .461 for calving difficulty score. It appeared in this data that the calf birth weight was more highly correlated to being pulled or not and to calving difficulty

Table 11

Relationship Between Characteristics and Ease of Calving, Pelvic Girdle Opening, Percent Calves Born Alive, and Calf Birth Weight

Characteristics	No. of Observ.	Dams Wt. (5/2/66)	Pelvic Girdle Opening sq. cm.	Hook Width cm.	Avg. Calf Birth Wt.	% Calves Pulled	Calving Diff. Score	% Calves Born Alive	Avg. Wt. Calves Born Alive	% Calves Dead At Birth	Avg. Wt. Calves Dead At Birth	% Calves Born
Pure Mean	82	499.00	170.46	30.96								
Hormone Treatment												
Single Implant	18	511.94	217.89	42.72	62.31	7.69	1.15	92.31	61.25	7.69	75.00	72.22
Reimplanted	18	494.67	213.32	43.15	61.92	25.00	1.42	83.33	61.00	16.67	66.50	66.67
Control	46	491.09	219.09	42.65	59.58	27.27	1.34	90.91	59.35	9.09	62.67	95.65
Nutrition Treatment												
Ration No. 1	28	495.89	217.47	42.84	60.71	20.83	1.04	87.50	60.71	12.50	60.67	85.71
Ration No. 2	27	498.33	221.75	42.30	61.55	25.00	1.07	90.48	60.89	9.52	74.00	77.78
Ration No. 3	27	494.81	213.48	43.18	59.46	25.00	1.22	91.67	58.50	8.33	70.00	88.89
Source												
Meinhart	42	488.81	222.76	42.46	61.63	33.33	1.48	90.91	62.86	9.09	74.50	78.57
Ferrell	40	504.25	212.10	43.10	59.53	13.89	1.17	88.89	66.97	11.11	61.75	87.50
Sex of Calf												
Bull	35	493.29	217.71	42.57	66.79	37.14	1.54	91.43	62.19	8.57	71.33	100.00
Heifer	33	502.58	219.60	43.29	57.91	9.09	1.09	90.91	57.63	9.09	60.67	100.00

Table 11 continued on Page 55

Table 11 (Continued)

Characteristics	No. of Observ.	Dams Wt. (5/2/66)	Pelvic Girdle Opening sq. cm.	Hook Width cm.	Avg. Calf Birth Wt.	% Calves Pulled	Calving Diff. Score	% Calves Born Alive	Avg. Wt. Calves Born Alive	% Calves Dead At Birth	Avg. Wt. Calves Dead At Birth	% Calves Born
Pure Mean	82	499.00	170.46	30.96								
Interactions												
Hormone x Nutrition												
Single Imp.-Ration 1	6	495.00	222.36	43.13	62.40	-	1.00	100.00	62.40	-	-	83.33
Single Imp.-Ration 2	6	523.33	228.02	42.92	65.00	-	1.00	100.00	65.00	-	-	33.33
Single Imp.-Ration 3	6	515.83	203.32	42.13	61.33	16.67	1.33	83.33	58.60	16.67	75.00	100.00
Reimplanted-Ration 1	6	491.67	207.12	43.61	65.00	25.00	1.25	75.00	67.00	25.00	59.00	66.67
Reimplanted-Ration 2	6	495.00	223.06	42.12	64.60	40.00	1.80	80.00	62.25	20.00	74.00	83.33
Reimplanted-Ration 3	6	497.50	209.78	43.71	53.33	-	1.00	100.00	53.33	-	-	50.00
Control-Ration 1	16	497.81	219.51	42.45	59.00	26.67	1.27	86.67	58.62	13.33	61.50	93.75
Control-Ration 2	15	489.67	218.72	42.12	59.85	21.43	1.20	92.86	59.85	7.14	*	93.33
Control-Ration 3	15	485.33	219.10	43.39	59.93	33.33	1.47	93.33	59.57	6.67	65.00	100.00
Hormone x Source												
Single Imp.-Meinhart	9	506.67	223.45	42.79	64.67	16.67	1.33	83.33	62.60	16.67	75.00	66.67
Single Imp.-Ferrell	9	516.11	212.35	42.65	60.29	-	1.00	100.00	60.29	-	-	77.78
Reimplanted-Meinhart	9	478.33	213.74	42.41	68.50	25.00	1.50	75.00	66.67	25.00	74.00	44.44
Reimplanted-Ferrell	9	511.11	212.89	43.89	58.63	25.00	1.38	87.50	58.57	12.50	59.00	88.89
Control-Meinhart	24	485.63	225.89	42.36	59.55	39.13	1.52	95.65	59.55	4.35	*	95.83
Control-Ferrell	22	496.59	211.68	42.97	59.62	14.29	1.14	85.71	59.11	14.29	62.67	95.45
Nutrition x Source												
Ration 1 - Meinhart	14	494.29	225.02	43.18	61.00	18.18	1.18	100.00	61.00	-	-	78.57
Ration 1 - Ferrell	14	497.50	209.91	42.50	60.46	23.08	1.23	76.92	60.40	23.08	60.67	92.86
Ration 2 - Meinhart	14	489.64	220.30	42.09	63.78	44.44	1.78	80.00	62.50	20.00	74.00	71.43
Ration 2 - Ferrell	13	507.69	223.31	42.52	59.73	9.09	1.18	100.00	59.73	-	-	84.62
Ration 3 - Meinhart	14	482.50	222.97	42.12	60.58	41.67	1.67	91.67	59.27	8.33	75.00	85.71
Ration 3 - Ferrell	13	508.08	220.19	44.33	58.33	8.33	1.08	91.67	57.73	8.33	65.00	92.31

*Calf was devoured by coyotes before sex or birth weight could be determined.

score than the correlation for these same factors with pelvic girdle opening which had a correlation of .123 and -.123 respectively, see Table 13.

The single implant heifers had 7.69% of their calves dead at birth with an average weight of 75.00 lb. The reimplanted heifers had a 16.67% death loss at birth with an average weight of 66.50 lb. The control heifers had a 9.09% death loss at birth and the calves had an average birth weight of 62.67 lb.

The heifers in the ration No. 1 group had 12.50% of their calves dead at birth with an average birth weight of the dead calves being 60.67 lb. The heifers in rations 2 and 3 had birth death losses of 9.52% and 8.33% respectively with calf birth weights of 74.00 lb. and 70.00 lb., see Table 11.

Even though the Ferrell heifers had 28.05% fewer calves pulled than the Meinhart heifers, their death loss at birth was higher with 11.11% calves lost versus 9.09% for the Meinhart heifers. The Ferrell calves lost at birth averaged 61.75 lb. while the Meinhart calves lost at birth averaged 74.50 lb. Similar results were obtained when comparing the death losses between bull calves versus heifer calves pulled. The bull calves pulled had an average death loss at birth of 8.57% while the loss of heifer calves was 9.09%. The bull calves dead at birth averaged 71.33 lb. while the heifer calves lost at birth weighed only 60.67 lb., see Table 11.

Only three of the calves dead at parturition were pulled. The other calves were found dead in the pasture and most of them still had placental membranes on them indicating that they died prior to parturition or during the act of parturition itself.

There were no known cases of abnormal presentations such as breech births, and all the calves pulled were in a normal birth presentation.

It appeared that the lighter calves were born earlier in the calving season from dams of lighter weight, see Table 13.

Calving Difficulty and Death Loss at Calving

Even though the heifers were checked several times a day during the calving season, there were a few calves which were either born dead at term or more feasibly died during parturition as a result of dystocia. There also was a problem with coyotes during the calving season which resulted in one calf being completely consumed before it was possible to determine the sex or birth weight. There was no direct evidence that any calf found dead at birth was killed as a result of coyotes.

In regard to assistance rendered at the time of parturition, no assistance was given unless it was apparent that the heifer in question was in distress and the feasibility of losing the calf, undue stress or damage to the heifer, or both was evident. At such times as it appeared necessary the calf was pulled using a pulling hook and obstetrical chains or if necessary a calf puller.

The single implant heifers had 7.69% of their calves pulled with the average birth weight of the pulled calves being 75.00 lb., with an average calving difficulty score of 1.15, see Table 11. The reimplanted heifers had 25.00% of their calves pulled with the average weight of the pulled calves being 69.33 lb. The calving difficulty score for the reimplanted heifers was 1.42. The control heifers had 27.27% of their calves pulled with the average birth weight of the pulled calves being 63.33 lb. and a calving difficulty score of 1.34.

It appeared that the majority of the calves pulled were either hip locked or shoulder locked; the majority of the calves appeared to be shoulder locked. In the largest percentage of the cases involving calves lost during parturition in the pasture with no assistance, the calves' heads and tongues were badly swollen indicating a long and strenuous birth.

Three heifers in the control group which lost calves were semi-paralyzed due to dystocia at parturition. One of the heifers suffered a complete prolapse of the uterus and required surgical assistance. All three of the heifers recovered after 1-3 days. One heifer in the single implant group suffered temporary partial paralysis as a result of parturition and required the assistance of a veterinarian to pull a dead 75.00 lb. calf.

The data from this experiment indicates that the pelvic girdle opening appears not to be as critical a factor in regard to parturition difficulty as has been indicated by Wiltbank (1961) and Lefever (Undated. Unpublished mimeograph material, U. of Wyom., Laramie.). For example, the control heifers had an average pelvic girdle opening of 219.09 sq. cm. and required 27.27% of their calves pulled, while the single implant heifers had an average pelvic girdle opening of 217.89 sq. cm. and required only 7.69% of their calves pulled.

The Meinhart heifers had an average pelvic girdle opening of 222.76 sq. cm. and required 33.33% of their calves pulled versus the Ferrell heifers with an average pelvic girdle opening of only 212.10 sq. cm. requiring 13.89% calves pulled. Not only did the Ferrell heifers require 19.44% less calves pulled, but their calves pulled averaged 4.11 lb. more at birth, see Table 11.

There may possibly be some experimental error in the determination of the pelvic girdle opening. The heifers were only measured once, using a different instrument than used by Wiltbank (1961) and Lefever (Undated. Unpublished mimeograph material, U. of Wyom., Laramie.), and for this reason there could be some error in the measurements. There needs to be additional use of the instrument used by the author to determine further the validity of the technique.

There may be inherent genetic factors involved which have some effect upon ease of calving. We know that the broad ligaments and pelvic structure relaxes and expands or stretches during parturition under the influence of estrogenic hormones and also relaxin. The single implant heifers required only 7.69% of their calves pulled while the reimplanted and control heifers required 25.00%

Table 12

Effect of Characteristics on Calf Birth Date*

Characteristics	F-Test	No. of Observ.	Calf Birth Date Deviation From Mean, days
Mean Day - 10.62 (Approximately 3/4/67)		69	
Hormone Treatment	Non sig.		
Single Implant		13	-3.35 ± 2.51
Reimplanted		12	-2.26 ± 2.64
Control		44	5.61 ± 2.86
Nutrition Treatment	Non sig.		
Ration No. 1		24	-4.05 ± 2.63
Ration No. 2		20	0.93 ± 2.65
Ration No. 3		24	3.12 ± 2.94
Source	Non sig.		
Meinhart		33	-1.12 ± 2.46
Ferrell		36	1.12 ± 2.46
Interactions**			
Hormone x Nutrition	$P < .05$		
Single Imp. - Ration 1		5	-3.97 ± 5.25[ab]
Single Imp. - Ration 2		2	-12.89 ± 5.26[b]
Single Imp. - Ration 3		6	16.86 ± 5.22[c]
Reimplanted - Ration 1		4	3.41 ± 5.18[a]
Reimplanted - Ration 2		5	9.55 ± 6.66[c]
Reimplanted - Ration 3		3	-12.96 ± 6.71[b]
Control - Ration 1		15	0.57 ± 4.09[ab]
Control - Ration 2		14	3.34 ± 4.08[ab]
Control - Ration 3		15	-3.91 ± 4.21[ab]

* The calving season was 66 days long, and day 1 was considered February 22, 1967, the day calving started.

**All values with the same superscript are not significantly different at the 5 percent level.

Table 13

Correlation Values Between Characteristics

Characteristics	Date of Birth	Calf Birth Weight	Pelvic Girdle Area	Hook Width	Heifer Body Weight 5/2/66	Calf Pulled or not Pulled	Calving Difficulty Score	Source
Sex of calf	-.387	-.368	.044	.202	.112	.332**	-.361**	.090
Date of birth		.250*	-.228	-.214	-.342**	-.203	.265*	-.135
Calf birth weight			.085	.256	.260	-.379**	.461**	-.152
Pelvic girdle area				.082	.205	.123	-.123	-.249
Hook width					.575**	.129	-.104	.181
Heifer body weight 5/2/66						.054	-.019	.185
Calf pulled or not pulled							-.928**	.230*
Calving difficulty score								.254*

* $P < .05$

** $P < .01$

and 27.27% respectively. There may be a relatively low threshold involved using exogenous estrogen (DES) which would reduce the incidence of calving difficulty. The exact mechanisms involved and the role played by hormones during parturition are not clearly defined and considerable study needs to be conducted in this area. It appeared in this study that the larger or heavier heifers had less difficulty at parturition, see Table 11.

SUMMARY

The purpose of this study was to determine the effects of DES on pelvic girdle opening, hook width, percent calf crop, calf birth weight, dams body weight, and ease of calving.

Eighty-two choice grade Hereford heifer calves were obtained from two sources in Kansas; the Meinhart ranch at Saint Marys and from the Ferrell ranch at Beaumont.

The 42 Meinhart heifers were randomly allotted into three lots of 14 heifers each, and each lot was assigned one of three winter supplement rations. The total amount of supplemental protein and energy received was the same for all treatments, only the source of protein and time of feeding energy varied. The hormone treatment consisted of six heifers randomly selected from each lot and implanted subcutaneously in the ear with 15 mg. of DES at the onset of the test. Ninety-eight days later three of the implanted heifers were randomly selected from each lot and reimplanted with 15 mg. of DES. The three lots were replicated according to treatment.

During all phases of the study the heifers were grazed on native bluestem pastures. Salt and fresh water were available ad libidum.

The heifers were fed the winter supplement while on pasture; no hay was fed unless snow prevented grazing. The heifers were weighed every 30 days

except during the calving season. The heifers were bred naturally to calve as 2 year olds using four purebred Angus bulls. Calf birth weights were recorded, calving difficulty scored, and the calves identified using ear tags and tattooing the ears. After termination of the calving season, the heifers were bred back to the same Angus bulls used the previous season.

Pelvic girdle opening and hook width measurements were taken 3 months prior to calving as 2 year olds. Statistical analysis of the data showed no significant effect of hormone treatment or nutrition treatment on pelvic girdle opening at the 5 percent level. There was no significant correlation between pelvic girdle opening and hook width.

The source of the heifers and also body weight were significant ($P < .05$) in affecting pelvic girdle opening. The Meinhart heifers had larger pelvic girdle openings, and the heavier heifers also had larger pelvic girdle openings.

Neither hormone treatment, nutrition treatment, nor source of the heifers had a significant effect on hook width at the 5 percent level.

Body weight was very highly significant ($P < .001$) in affecting hook width. The heavier heifers had more width between their hooks; fleshing and thickness of the hide will affect hook width. The data showed no significant influence on dams body weight at the 5 percent level for any treatment or for source of heifers.

The implanted heifers had higher tail heads, increased mammary development, and longer teats than the control heifers. Some of the implanted heifers exhibited low loins; no incidence of excessive riding or prolapse was evident. The implanted heifers had a greatly reduced conception rate in comparison with the control heifers. The nutritional treatments had little effect on conception rate. The Ferrell heifers had a higher conception rate than the Meinhart heifers indicating a source factor was involved.

The most significant effect of the hormone treatment was in reducing calving difficulty. The single implanted heifers required only 7.69% of their calves pulled, while the reimplanted and control heifers required 25.00% and 27.27% of their calves pulled respectively. Source was a significant factor in regard to calving difficulty; 33.33% of the Meinhart calves were pulled, while only 13.89% of the Ferrell calves required pulling. The sex of the calf pulled was significant; 37.14% of the bull calves required pulling while only 9.09% of the heifer calves were pulled.

The lighter heifers appeared to have earlier calves with lighter weights than the heavier heifers which calved later in the season and produced heavier calves.

The pelvic girdle opening was not a major factor in determining ease of calving in this study. The body weight of the dam appeared to have more influence on ease of calving than pelvic girdle opening. The sex of the calf and body weight were big factors in determining ease of calving.

There appear to be hormonal and inherent genetic factors which exhibit a great deal of influence in regard to ease of calving. For example, the single implant heifers had smaller pelvic girdle openings than the control heifers and still had approximately 20% fewer calves pulled. This study indicated that there doesn't appear to be any economic benefit in implanting breeding females with DES due to a greatly reduced conception rate.

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THE EFFECTS OF DIETHYLSTILBESTROL ON PELVIC AREA, PERCENT CALF CROP, CALVING DIFFICULTY AND BODY SIZE RELATIONSHIPS IN HEREFORD HEIFERS

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The purpose of this study was to determine the effects of diethylstilbestrol (DES) on pelvic girdle opening, hook width, percent calf crop, calf birth weight, dams body weight, and ease of calving.

Eighty-two choice grade Hereford heifer calves were obtained from two sources in Kansas. The heifers from each source were randomly sorted into three lots with 13 or 14 heifers in each lot. Each lot was assigned one of three winter supplement rations. The total amount of supplemental protein and energy received was the same for all treatments, only the source of protein and time of feeding energy varied. The hormone treatment consisted of six heifers randomly selected from each lot and implanted subcutaneously in the ear with 15 mg. of DES at the onset of the study. Ninety-eight days later three of the implanted heifers were randomly selected from each lot and reimplanted with 15 mg. of DES.

During all phases of the study the heifers were grazed on native bluestem pastures. Salt and fresh water were available ad libidum.

The heifers were fed the winter supplement while on pasture; no hay was fed unless snow prevented grazing. The heifers were weighed monthly except during the calving season. Breeding was done naturally using four purebred Angus bulls, and the heifers were bred to calve as two year olds. Calf birth weights were recorded, calving difficulty scored, and the calves identified using ear tags and tattooing the ears. After termination of the calving season, the heifers were bred back to the same Angus bulls used the previous season.

Pelvic girdle opening and hook width measurements were taken 3 months prior to calving as 2 year olds. Statistical analysis of the data showed no significant effect of the hormone treatment or nutritional treatment on pelvic girdle opening at the 5 percent level. There was no significant correlation between pelvic girdle opening and hook width. The source of the heifers and also body weight were significant ($P < .05$) in affecting pelvic girdle opening. The heifers from the Meinhart ranch at Saint Marys had larger pelvic girdle openings, and the heavier heifers also had larger pelvic girdle openings.

The hormone treatment, nutrition treatment, and source had no significant effect on hook width at the 5 percent level. Heifer body weight was very highly significant ($P < .001$) in affecting hook width. The heavier heifers had more width between their hooks. The data showed no significant influence on dams body weight at the 5 percent level for any ration or hormone treatment or for source of the heifers.

The implanted heifers had higher tail heads, increased mammary development, and longer teats than the control heifers. Some of the implanted heifers exhibited low loins; no incidence of excessive riding or prolapse was evident. The implanted heifers had a greatly reduced conception rate in comparison with the control heifers. The nutritional treatments had little effect on conception rate. The Ferrell heifers had a higher conception rate than the Meinhart heifers indicating a source factor was involved.

The most significant effect of the hormone treatment was in reducing calving difficulty. The single implanted heifers required only 7.69% of their calves pulled, while the reimplanted and control heifers required 25.00% and 27.27% of their calves pulled respectively. Source of the heifers was a significant factor in regard to calving difficulty; 33.33% of the Meinhart calves were pulled, while only 13.89% of the Ferrell calves required pulling. The sex of the calf pulled was significant; 37.14% of the bull calves required pulling while only 9.09% of the heifer calves were pulled.

It appeared that the lighter heifers had earlier calves with lighter weights than the heavier heifers which calved later in the season and produced heavier calves.

The pelvic girdle opening was not a major factor in determining ease of calving in this study. The body weight of the dam appeared to have more influence on ease of calving than pelvic girdle opening. The sex of the calf and body weight were big factors in determining ease of calving.

There may be hormonal and inherent genetic factors which exhibit a great deal of influence in regard to ease of calving. For example, the single implant heifers had smaller pelvic girdle openings than the control heifers and still had approximately 20% fewer calves pulled. This study indicated that there doesn't appear to be any economic benefit in implanting breeding females with DES due to a greatly reduced conception rate.